FORMWORK CONSIDERATIONS

AP Form Liners can be used with any concrete forming system. They provide unique designs and economical solutions to forming architectural concrete surfaces. Reuses are guaranteed for 100 if the form liner is adhered to a surface such as wood. Certain patterns of deeper relief may not yield as many reuses. Be sure to contact an AP representative to verify. Acceptable dimensional tolerances for form liners are ± 3/16 of an inch.

SAFETY NOTE: Failure to provide adequate support against the concrete pressures could result in a "blowout", subjecting workers to injury and causing job delays. Form Liners can also be used in tilt-up and pre-cast applications. An architectural representative should be consulted when considering such applications.

Form Placement

It is important that forms for architectural concrete be aligned and in common planes. Manufacturing tolerances can result in forms being in different planes. This creates a noticeable line in the finished surface, particularly with shallow Form Liner patterns. All formwork should be sufficiently rigid to remain sealed during concrete placement and vibration. Seal all joints and tie holes by caulking or gasketing to prevent grout leakage.

Tie Placement

Plan formwork so that tie placement is at rustications, reveals or other inconspicuous locations, to minimize the visual effect in the finished surface. Remember to allow for the depth of the Form Liner when calculating the breakback requirement for ties.
When using a rib pattern Form Liner, locate ties at the high point of the Form Liner rib. This places the tie in the recess of the finished surface where it is less noticeable. The maximum diameter of the tie (cone, She-Bolt, Taper Tie) should not exceed the minimum width of the rib. Provide a minimum of 1" concrete cover for ties requiring breakback. If cones are used, the diameter of the cone should be less than its depth to facilitate patching.

To minimize grout leakage through tie holes when using SPS and ABS Plastic Form Liner, foam tape or foam rod should be used. This packing material is used to fill any space around the tie. Packing should be done from the face of the form and extend 1/8” through the SPS or ABS Plastic Form Liner.

The rubber-like nature of elastomeric form liners simplifies sealing the tie holes. A slightly smaller tie hole diameter (1/16" less) in the form liner will create a gasket effect and minimize grout leakage. Of course, the tie hole in the plywood or steel backing must be large enough to accept the tie being used.

**SAFETY NOTE:** Burning tie holes in the Form Liner with a heated tie or other tool emits toxic fumes that may cause injury if inhaled. If workers inhale fumes, move them to fresh air and contact a physician if needed.

**Form Liner Joints**

It is very difficult to match pattern features at joints and make the surface appear continuous. Slight differences in shape, thickness and texture will have a visible impact on the finished surface. For this reason, avoid or minimize both vertical and horizontal joints.

When joints are unavoidable, make the joint along the main features of the pattern. Match pattern features carefully, and minimize grout leakage at the joint with foam tape. This practice will help reduce the visible effect on the finished surface.

Consider the pattern dimensions to achieve an overall balanced design. It is especially important to consider pattern dimensions when planning for unavoidable joints, boxouts and corners in the finished surface.

**Rustication**

Rustication strips are often used at Form Liner joints. This not only accentuates the pattern, but also eliminates the need to produce a perfect pattern joint. It is recommended that rustication be applied as a closure on the top of the pattern and sealed with foam tape.
There are many different types of reusable rustications that are compatible with form liners. The rustication is strong enough to resist concrete pressures and flexible enough to conform to curves.

**Boxouts**

There are two methods of forming boxouts; one requires permanently modifying the form liner, the other applies a closure to the face of the form liner.

Boxouts by modification require that the Form Liners be cut to accommodate the boxouts. The location of the pattern features should be determined before fabricating the required boxouts.

Boxouts by closure do not require that the Form Liners be cut. The required boxouts are placed over the Form Liner, and materials are used to fill the voids between the boxouts and the Form Liner surface. The materials used are dependent on the configuration of the Form Liners and the concrete pressures.

**Corners**

Corners by modification require that the Form Liners be cut to accommodate the corners. The location of the pattern features should be determined before fabricating the required corners. Consider ordering a manufactured corner system custom built for our particular need.

Corners by closure do not require that the Form Liners be cut. A smooth reveal is used at inside or outside corners to simplify corner formwork construction and minimize pattern misalignment at the corners.

**Reinforcing Steel**

Locate reinforcing steel accurately to insure proper cover and eliminate rust stains on the finished concrete surface. The clear distance between the outermost reinforcing bar and the surface should be at least 2". Remember to allow for the thickness of the form liner pattern when calculating the proper cover for the reinforcing steel.

Provide a minimum of 5" x 5" clear opening in reinforcing steel throughout, for proper placement and vibration of concrete. Use maximum diameters in calculating steel spacing and clear openings. These placement and vibration openings should be consistent with the capabilities of the vibration equipment. Further recommendations are contained in ACI 309-92.

**Test Pour**
Before actual construction, a test pour is recommended to demonstrate the results on the finished concrete surface. The test pour should simulate as many phases of the actual construction as possible and include typical tie holes, boxouts, corners, reveals, wall intersections and joints. The test pour should be the height of the maximum wall to be produced.

Upon approval, the actual construction should proceed using the same methods and materials to assure uniformity throughout the entire project.

**Attachment Procedures for Elastomeric Formliners**

The AP Form Liner is a premium form liner, combining great resilience and high tensile strength. This material provides superior toughness and wear resistance so that reproduction of even the most difficult undercut and complex designs is consistent, even after many re-uses. Form liners not attached to a backing surface are not likely to allow 100 or more casts. Contact an AP representative for more information.

Elastomeric form liners are available in custom sizes in more than 60 patterns and new patterns are easily manufactured. These form liners expand and contract with temperature changes so it is best to install form liners at the temperature conditions that most closely approximate the time of concrete placement.

Thermal compatibility can be achieved by integrating a fiberglass mat when the form liner is in a liquid state during manufacture.

**NOTE:** Temperatures in excess of 150°F will cause permanent thermal decomposition in elastomeric form liners.

**NOTE:** Elastomerics can degrade when exposed to intense sunlight for extended periods of time. Cover the form liner surface with a tarpaulin or black plastic to shade the forming surface whenever it is not in use. This will prolong the life of the form liner material and keep the forming surface clean.

**Handling**

Avoid striking the face with heavy, sharp or heated objects that could cause permanent damage to the material.

**Materials and Tools**

The basic materials needed for field attachment and modification of elastomeric form liners include:
The quantities of materials needed will vary with the size of the project and the method of attachment.

The basic tools needed to attach and modify Form Liners include:

- Tape measure
- Chalk line
- Utility knife
- Power rotary rasp
- Saber saw with knife blade
- Power sander or grinder
- Hammer
- Electric drill with hole saw
- Measuring cup
- Serrated trowel (1/8”)
- Sprayer with wand extension
- Personal safety equipment

The quantities of tools needed will vary with the size of the project and the method of attachment.

**Cutting and Drilling**

AP elastomeric form liners can be modified by cutting and drilling. Use a utility knife or saber saw with a knife blade for cutting. A cylinder type hole saw can be used for drilling. Perform these operations on form liners that are securely clamped to a work bench with a cutting guide or drilling template. The work pace should be steady to prevent excess friction that can melt form liners and disable tools.

**SAFETY NOTE:** Sanding, cutting and drilling can create dust that might be inhaled. Long term exposure to this dust may be harmful. Workers should wear appropriate safety equipment.
The rough edges created by cutting and drilling can be dressed with a sander. Remember to remove all dust and debris from the surface. AP elastomeric form liners can be attached to handset systems, gangform systems or plywood (for subsequent mounting to gangform systems).

**Attachment - Handset Systems**

Procedures for attachment to handset systems include:
1. Assemble and brace the architectural side of the formwork first. Attach form liners before setting ties or opposite formwork side.
2. Position form liner against the formwork so that edges, pattern and joints are square. Work with one sheet at a time.
3. Tack top edge with box nails (or staples) approximately 6" on center, to hold position.
4. Using box nails (or staples); nail one side edge to the formwork approximately 6" on center. Check overall dimensions and position.
5. Continue using box nails (or staples) approximately 12" on center in both directions throughout the field of the form liner and 6" on center along the perimeters to complete the attachment.
6. Apply compressible adhesive backed foam tape to Form Liner edges and then firmly butt edges. Compress the joint as tightly as possible, without buckling or distorting the pattern.
7. Dress joints and edges with a power rotary rasp or sander to match pattern features as closely as possible.

**Attachment - Gangform Systems**

Procedures for attachment to gangform systems include:
1. Level and square the formwork so that attachment can be made in a horizontal plane. Mark dimensions so that edges, patterns and joints are square.
2. Roughen formwork face and back side of form liners to accept the adhesive. Clean dust and debris from both surfaces with solvent.

**NOTE:** Adhesives will not provide the adequate attachment if formwork contains residual form release or dust.

3. Snap lines on form for positioning. Position the form liners and roll back more than half onto itself. Work with one sheet at a time.
4. Prepare the adhesive according to instructions, and spread uniformly on the formwork face and back of Form Liner. Check edges and corners to be sure adhesive has been applied to these critical areas.
5. When adhesive is tacky, slowly roll the form liner back onto the formwork face. This rolling action eliminates air pockets between surfaces.
6. Position edges and corners, securing them with wood tack strips for dimensional stability.
7. Roll back the other half and apply adhesive to the formwork face and back of the form liner. Check edges, corners, and center adhesive line to be sure adhesive has been applied to these critical areas.
8. When adhesive is tacky, slowly roll the form liner back onto the formwork face. This rolling action eliminates air pockets between surfaces.
9. Position edges and corners, securing them with tack strips for dimensional stability. Allow 48 hours for complete setting.
10. Should joints be required, apply adhesive to form liner edges and butt edges firmly. Compress the joint as tightly as possible without buckling or distorting pattern.
11. Evenly weight down the form liner to assure consistent adhesion to the formwork face.
12. Dress joints and edges with a utility knife or sander to match pattern features as closely as possible.

**Attachment - Plywood**

Procedures for attachment to plywood include:
1. If a secondary underlayment is attached to forms, and the form liner attached to it, ¾” unoiled plywood should be used. If the form face sheet is not sacrificial, the best method of attachment is with Tee Nuts (1/4” min.) placed at 1’ on center for ½” plywood, and at 2’ on center for ¾” plywood. A washer is required on the back side of a plywood face sheet form. Do not use pressure treated plywood.
2. Roughen plywood face and back side of form liner to accept adhesive. Clean dust and debris from both surfaces with solvent.

**NOTE:** Adhesives will not provide adequate attachment if formwork contains residual form release.

3. Allow form liner to overhang edges by 1/16” when joints are required on the gang. Decide on anchoring method to be used for subsequent mounting to formwork.
4. Position the form liners and roll back more than half onto itself. Work with one sheet at a time.
5. Prepare the adhesive according to instructions and spread uniformly on the plywood face and back of form liner. Check edges and corners to be sure adhesive has been applied to these critical areas.
6. When adhesive is tacky, slowly roll the form liner back onto the plywood face. This rolling action eliminates air pockets between surfaces.
7. Position edges and corners, securing them with tack strips for dimensional stability.
8. Roll back the other half and apply adhesive to the plywood face and back of the form liner. Check edges, corners, and center adhesive line to be sure adhesive has been applied to these critical areas.

9. When adhesive is tacky, slowly roll the form liner back onto the plywood face.

10. Position edges and corners, securing them with tack strips for dimensional stability. Allow 48 hours for complete setting.

11. The plywood and form liner is now ready for mounting to formwork.

12. Mark dimensions so that edges, patterns, and joints are square when mounting.

13. Attach the plywood with form liner to the gangform. Screws should be driven from the back of the form face into the plywood. Screws should be positioned on 12” centers and capture ¾” of the plywood thickness.

14. Once mounted, dress joints and edges with a utility knife or sander to match pattern features as closely as possible.

### Attachment - Factory Installed

AP Elastomeric Form Liners can be attached to plywood at the factory according to customer specifications. The process is similar to the plywood attachment outlined above, but it takes place in a controlled factory setting. This type of attachment can greatly speed production at the work site. Customized attachment methods suited to specialized casting practices are available. Contact an AP representative to discuss.

### Repair

Cuts or tears in AP Elastomeric Form Liners can often be repaired with the AP Gel 80 adhesive. Work the adhesive into the edges of the cut or tear and weight the area while the adhesive is setting. After setting, lightly sand residual adhesive to avoid a gloss-producing spot in the concrete.

### Form Release

AP Elastomeric Form Liners are slightly oil absorbent when new. It is recommended that an initial spray of form release be brushed in to help "season" and clean the pattern. Work the form release into all areas, especially pattern recesses. AP Release 2550 is recommended.

Spray AP Elastomeric Form Liners with form release before each use and within the same day that concrete is placed. A form release sprayer should be used and spraying angle varied to insure complete coverage of all pattern features. Use a brush for deep or rough patterns.

Form releases will generally not adversely affect the Form Liners or concrete. They provide consistent release for easy stripping and prolong the useful life of the Form
Liners. They will not stain concrete, and leaves no residue, virtually eliminating any concrete dusting.

**NOTE:** Reprocessed oils used as form releases can damage Form Liners and cause degradation of liner material and stripping difficulties.

**Concrete Design**

The design of the concrete mix will affect the finished form liner appearance because it causes changes in workability, pressure, color, set and strength.

Load concrete onto the form liner from the centers, moving the concrete towards the outside perimeter with rakes. Do not allow concrete to be pushed under the form liner at joints.

**Concrete Considerations**

A properly finished surface not only depends on the formwork and Form Liners, but on several concrete factors.

**Concrete Mix**

Architectural concrete requires mix designs that can be consolidated with immersion vibrators that provide maximum workability consistent with strength requirements. Further recommendations are contained in ACI 303 (architectural cast-in-place), 211 (sand/aggregate and gradation), 301 (water/cement) and 309 (voids). Consolidation of the architectural concrete mix has a direct relationship to the quality of the finished surface.

Interesting effects can be achieved in architectural concrete by using gap-graded or colored aggregates in the concrete mix.

**Concrete Placement**

Place architectural concrete using a pump or conveyor, with a drop chute, to avoid separation of the concrete mix. If not controlled, rock pockets, "honey comb" and spatter marks may be evident in the finished surface.

Place architectural concrete in two foot continuous lifts, and do not move concrete horizontally. If horizontal movement is employed, flow lines and sand streaking will be evident in the finished surface. Do not stop concrete placement part way up the pattern; the resulting cold joint will be very apparent in the finished surface.
NOTE: The setting of concrete is an exothermic reaction and considerable heat can be generated. This heat, together with the effects of sun shining on the formwork, can cause temperatures in excess of 140° F that may damage the form liner.

**Vibration**

Proper consolidation is critical to architectural concrete and is normally accomplished by internal vibration. Recommended practice calls for vibrating one lift at a time, extending the vibrator 6" to 12" into the preceding lift. After a momentary pause, withdraw the vibrator slowly, at a rate of 1" to 2" per second. For deeply textured patterns, the rate of withdrawal should be proportionately decreased. Vibrate at intervals of 12" to 18", depending on the properties of the concrete mix and the radius of influence of the vibrator. The area affected by the vibrator should overlap the previously vibrated area by a few inches. To avoid variations in concrete color and texture, maintain a consistent interval from time of placement to time of vibration, throughout the entire project.

NOTE: Architectural concrete requires extensive vibration. Design formwork and seating procedures to resist the stresses caused by vibration of this type.

**Stripping Formwork**

Strip formwork with form liners at right angles to the form. The force required to strip a form will depend on the surface area of the pattern and on the percentage of the pattern at right angles to the direction of stripping. A shallow profile pattern will be easier to strip than a deep profile pattern.

The material resiliency of AP elastomeric Form Liners can be used to allow the formwork to strip itself. Use a hydraulic jack to separate (push) the top of the formwork from the concrete. Allow the jack to remain in place for approximately 15 minutes. The formwork will slowly resume its original shape and strip itself away from the finished surface. If jacking is not possible, a stripping force can be used on the back side of the form to separate (pull) the top of the formwork from the concrete. The stripping angle should always be as perpendicular to the form as possible.

NOTE: Excessive stripping force and formwork pivoting can cause damage to the finished surface.

Strip formwork with Form Liners within 24 hours of concrete placement. To avoid variations in concrete color, it is important to maintain consistent interval from time of placement to time of stripping, throughout the entire project.